US011294312B2

(12) **United States Patent**
Noda et al.

(10) **Patent No.: US 11,294,312 B2**
(45) **Date of Patent: Apr. 5, 2022**

(54) IMAGE FORMING APPARATUS TO ACCURATELY DETERMINE TEMPERATURE OF HEATING MEMBER

(71) Applicant: **BROTHER KOGYO KABUSHIKI KAISHA**, Nagoya (JP)

(72) Inventors: **Daisuke Noda**, Ichinomiya (JP); **Yuya Harada**, Anjo (JP)

(73) Assignee: **BROTHER KOGYO KABUSHIKI KAISHA**, Nagoya (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/188,277**

(22) Filed: **Mar. 1, 2021**

(65) **Prior Publication Data**

US 2021/0278789 A1 Sep. 9, 2021

(30) **Foreign Application Priority Data**

Mar. 3, 2020 (JP) JP2020-035428
Feb. 19, 2021 (JP) JP2021-025204

(51) **Int. Cl.**
G03G 15/20 (2006.01)
G03G 15/00 (2006.01)

(52) **U.S. Cl.**
CPC ***G03G 15/2039*** (2013.01); ***G03G 15/80*** (2013.01)

(58) **Field of Classification Search**
CPC G03G 15/2039
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

9,285,729 B2 * 3/2016 Saito G03G 15/2039
2007/0122170 A1 * 5/2007 Mashiba G03G 15/2039
399/33
2007/0122173 A1 5/2007 Mitsuoka et al.
(Continued)

FOREIGN PATENT DOCUMENTS

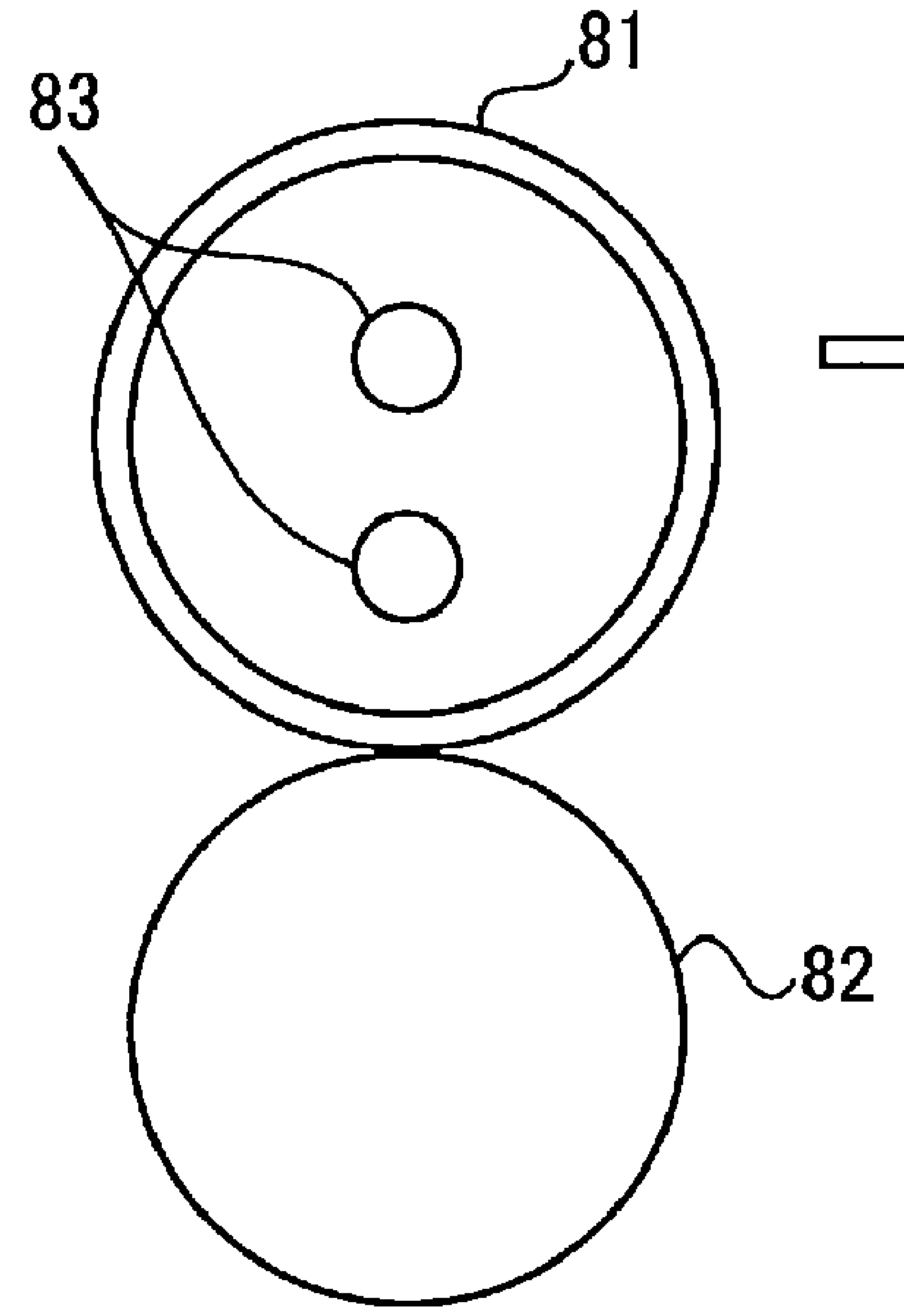
JP 2000-259038 A 9/2000
JP 2001-215843 A 8/2001
(Continued)

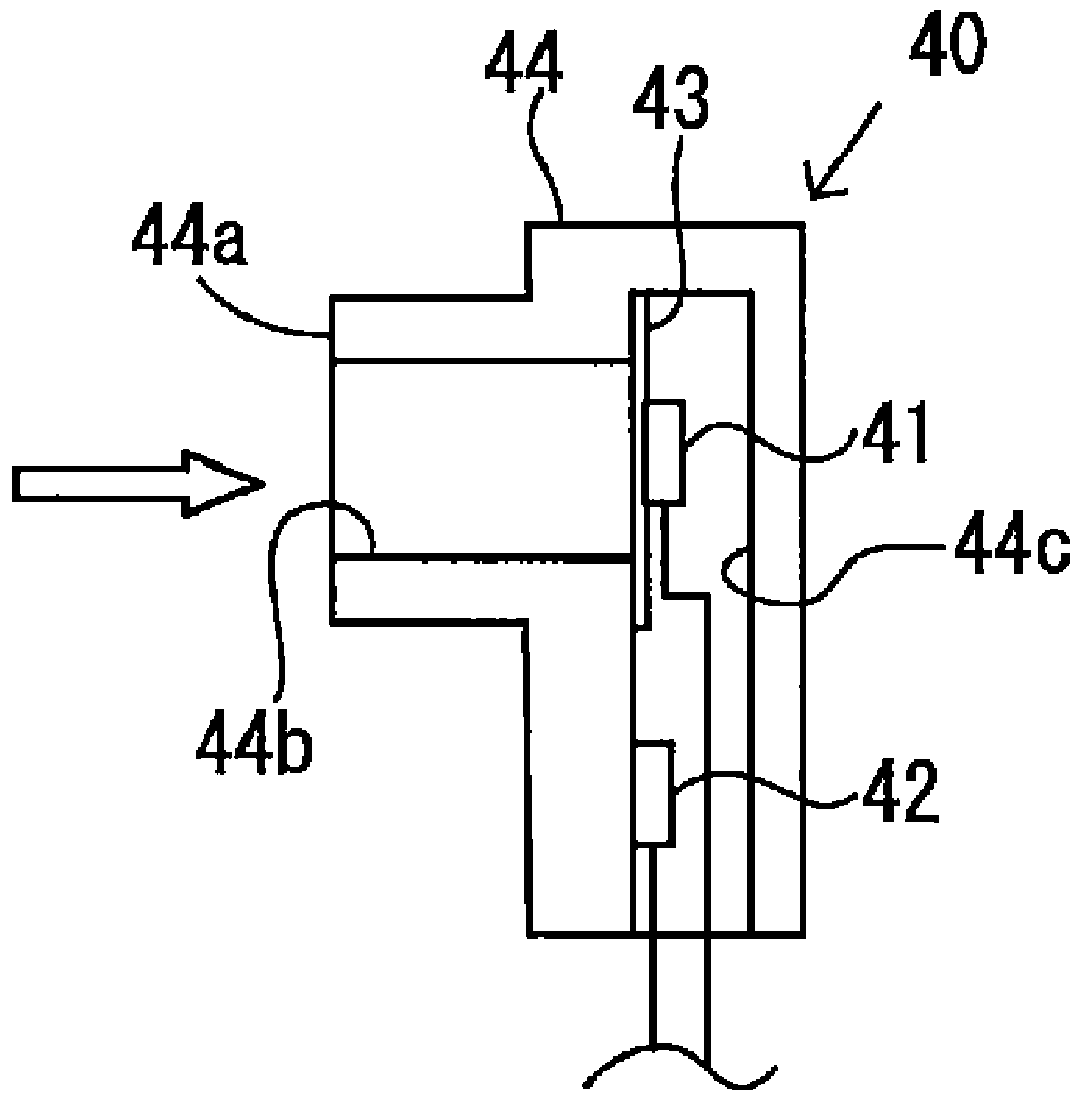
Primary Examiner — Carla J Therrien
(74) *Attorney, Agent, or Firm* — Merchant & Gould P.C.

(57) ABSTRACT

An image forming apparatus includes a heating member, a temperature sensor to output detection values for determining a temperature of the heating member, a first amplifier to amplify a difference value between the detection values with a first amplification factor, a second amplifier to amplify the difference value with a second amplification factor, a converter to generate first temperature information through analog-to-digital conversion of the difference value amplified by the first amplifier, generate second temperature information through analog-to-digital conversion of the difference value amplified by the second amplifier, and generate compensation temperature information, and a temperature determiner to determine the temperature of the heating member based on the second temperature information and the compensation temperature information, in a particular temperature range, and determine the temperature of the heating member based on the first temperature information and the compensation temperature information, outside the particular temperature range.

14 Claims, 7 Drawing Sheets





(56) References Cited

U.S. PATENT DOCUMENTS

2007/0140719	A1*	6/2007	Sato	G03G 15/2039 399/69
2008/0050139	A1*	2/2008	Nakajima	G03G 15/2039 399/69
2018/0266894	A1	9/2018	Nishiyama et al.	
2019/0033142	A1*	1/2019	Nishiyama	G01J 5/24

FOREIGN PATENT DOCUMENTS

JP	2002-311752	A	10/2002
JP	2003-257591	A	9/2003
JP	2003-302288	A	10/2003
JP	2007-173218	A	7/2007
JP	2017-106740	A	6/2017

* cited by examiner

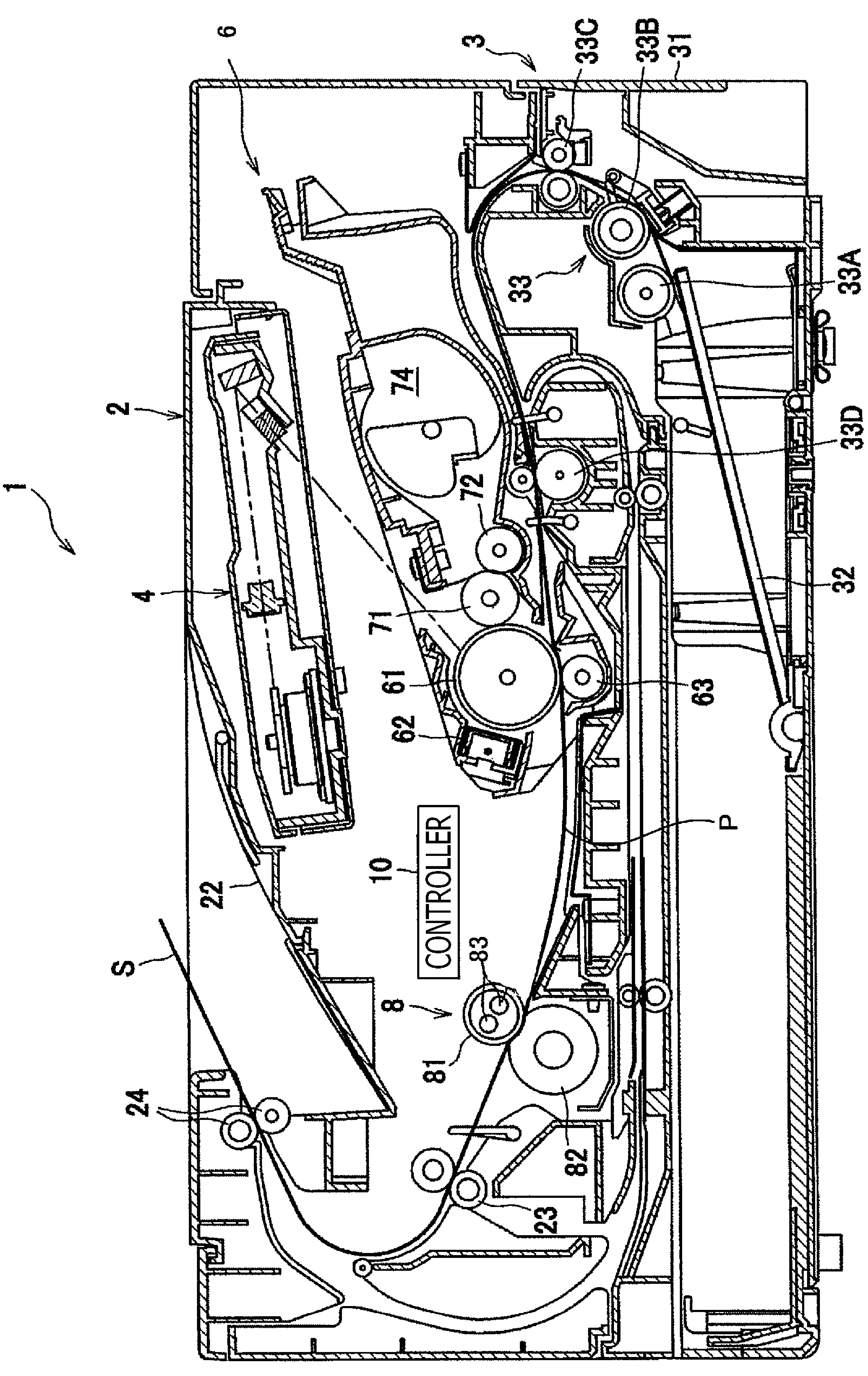

1
2
4
6
3
33C
33B
31
33
33A
74
72
71
61
62
63
33D
32
P
10
CONTROLLER
22
S
83
8
81
82
24
23

FIG. 1

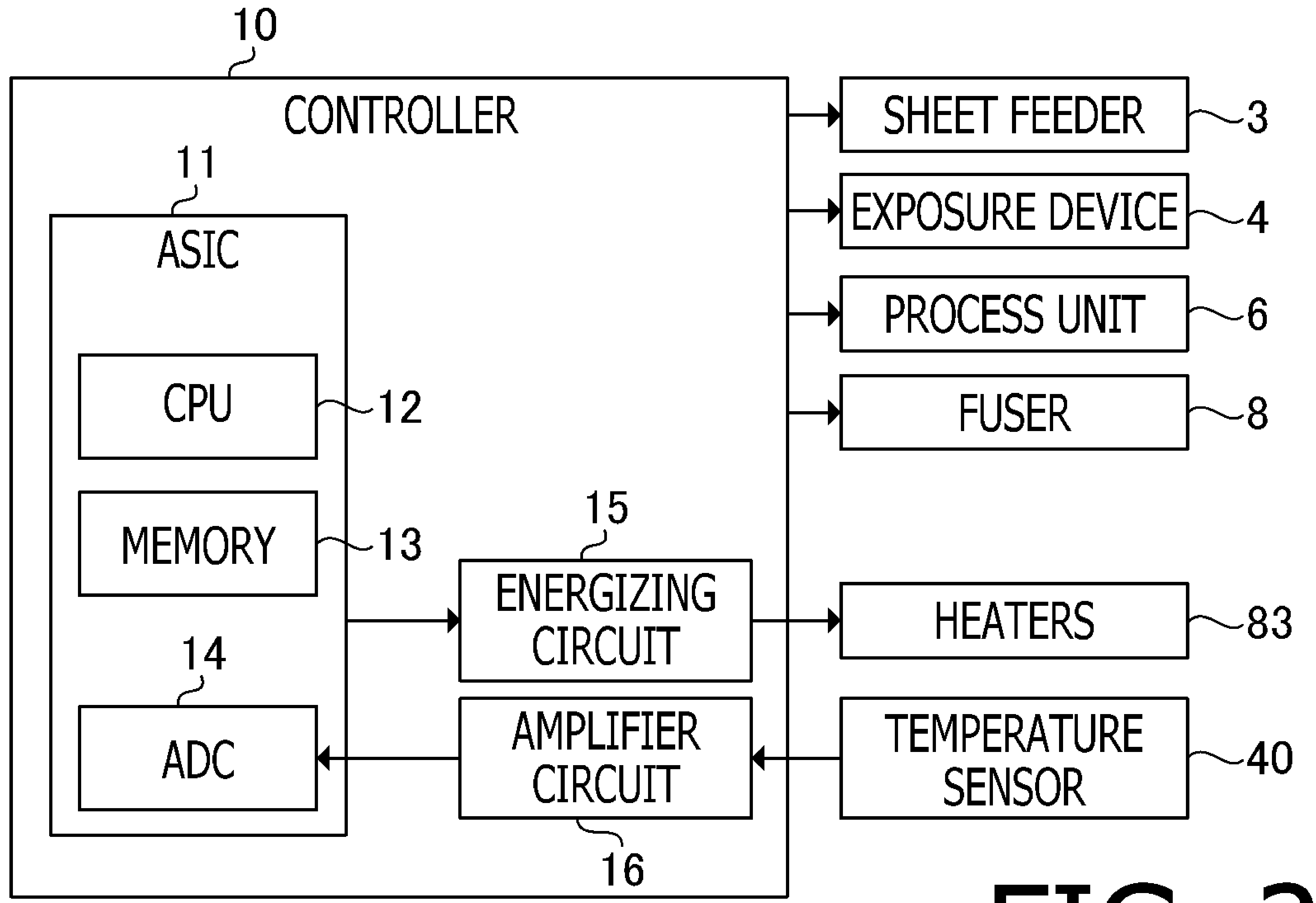

10
CONTROLLER
11
ASIC
CPU
12
MEMORY
13
14
ADC
15
ENERGIZING CIRCUIT
AMPLIFIER CIRCUIT
16
SHEET FEEDER
3
EXPOSURE DEVICE
4
PROCESS UNIT
6
FUSER
8
HEATERS
83
TEMPERATURE SENSOR
40

FIG. 2

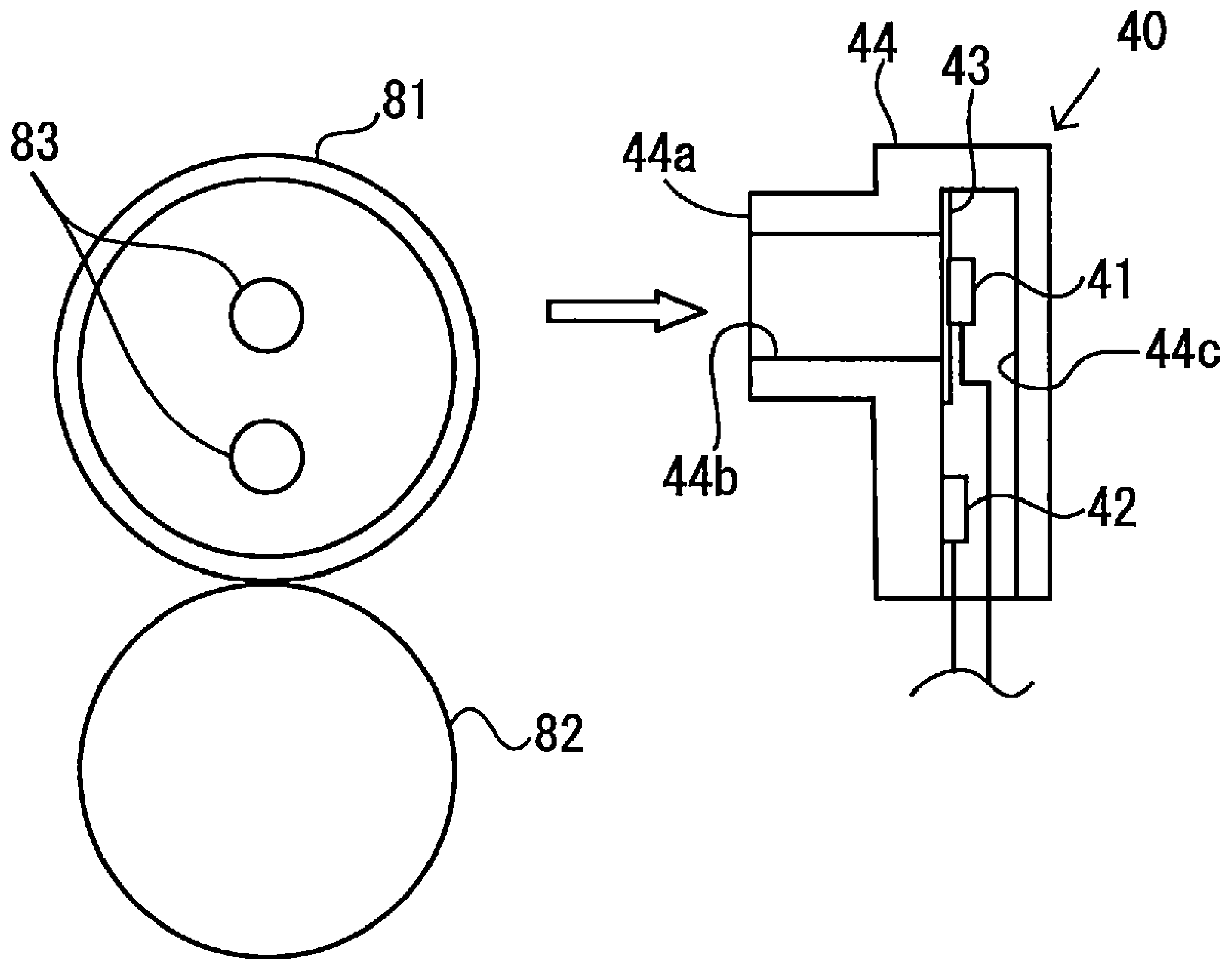

83
81
82
44
43
40
44a
41
44c
44b
42

FIG. 3

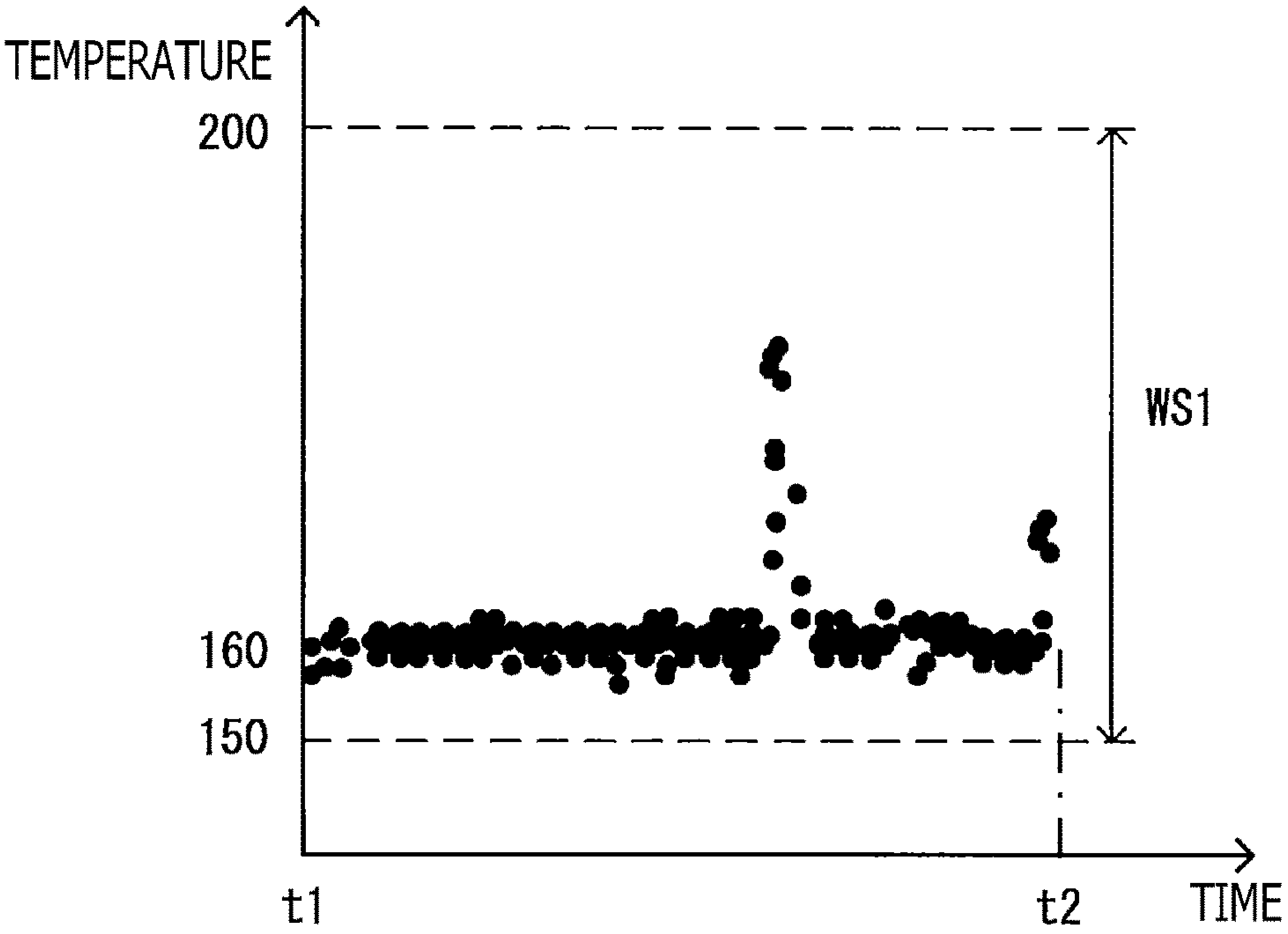

TEMPERATURE
200
160
150
WS1
t1
t2
TIME

FIG. 4

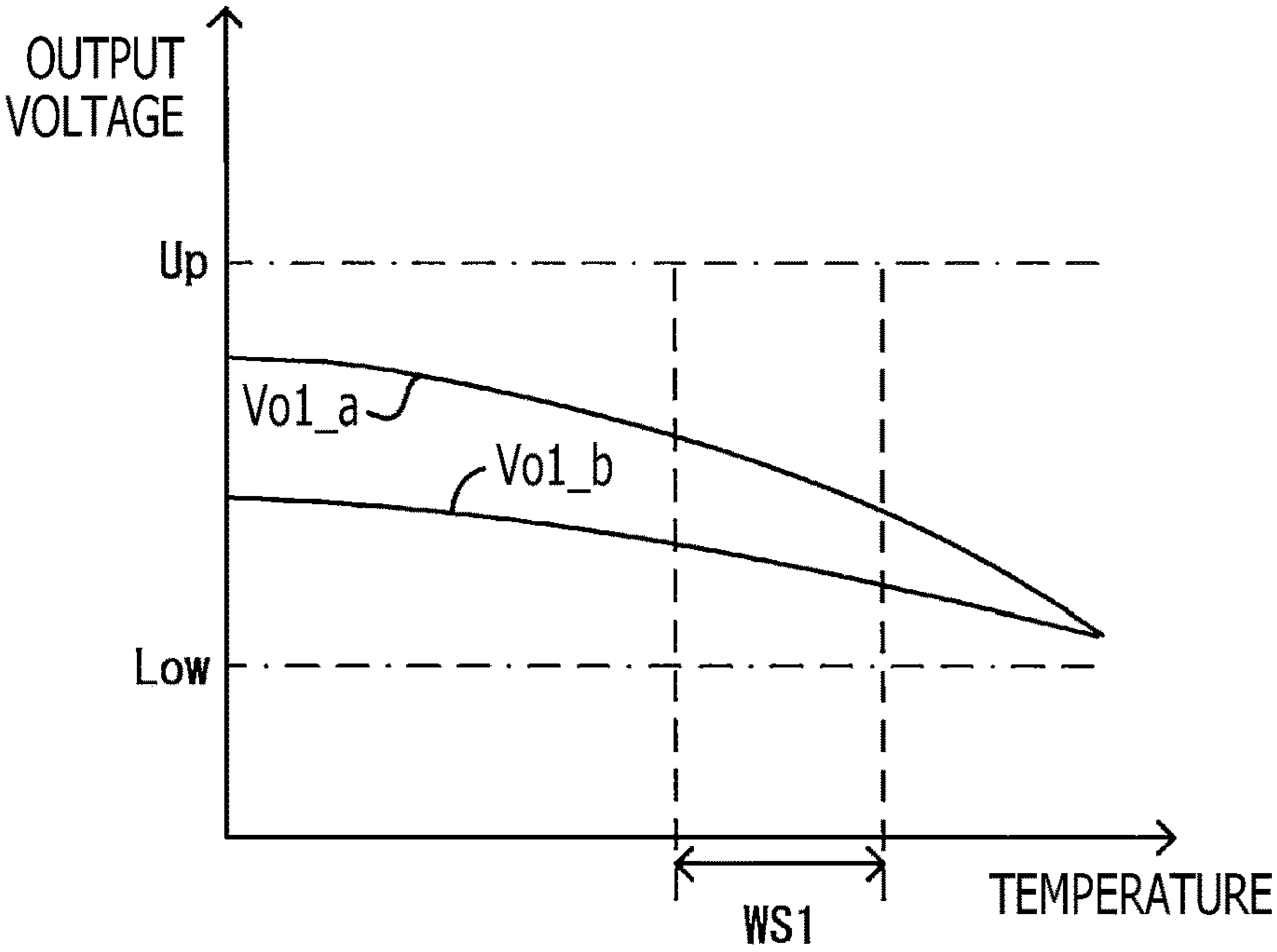

OUTPUT VOLTAGE
Up
Low
Vo1_a
Vo1_b
WS1
TEMPERATURE

FIG. 5

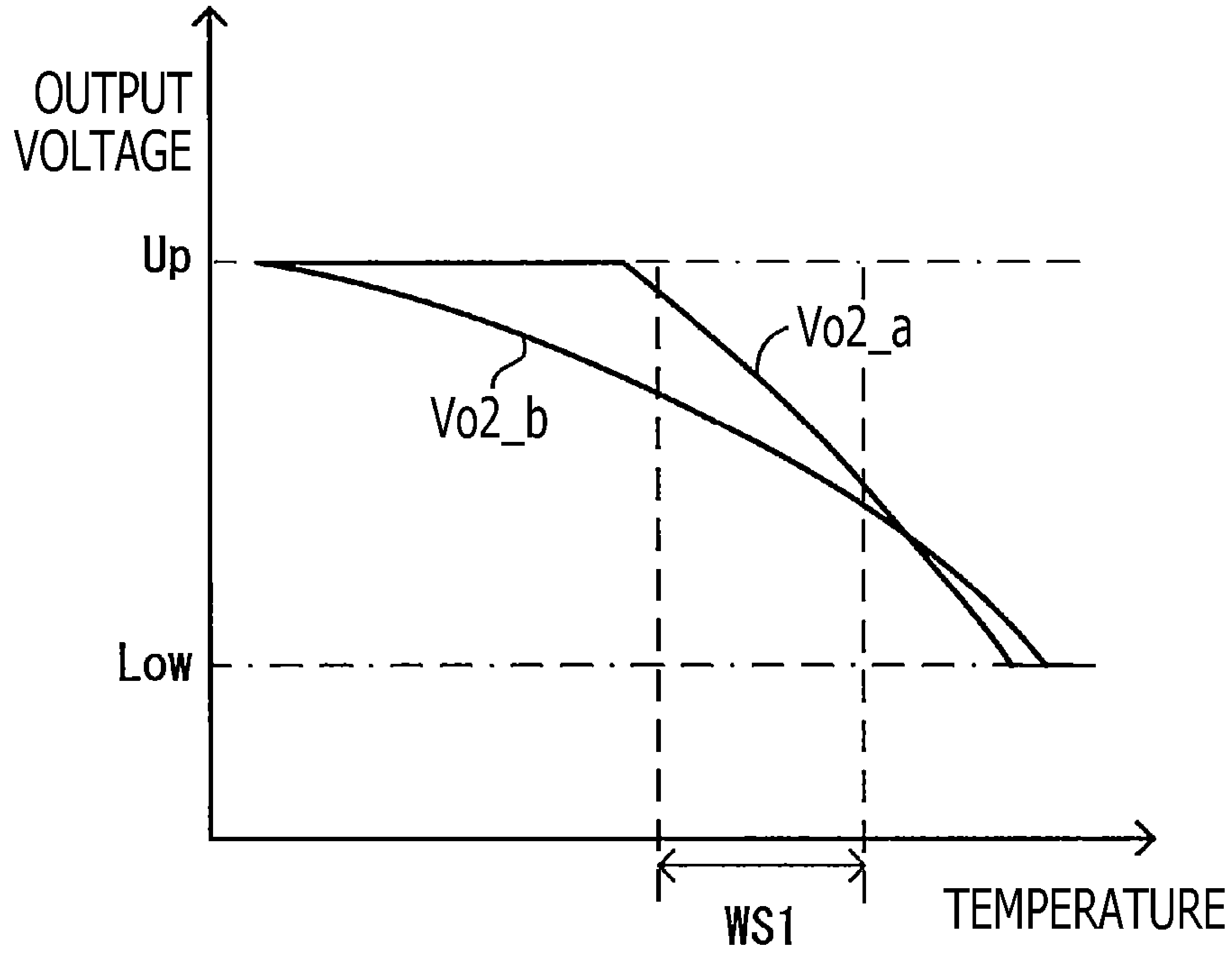


FIG. 6

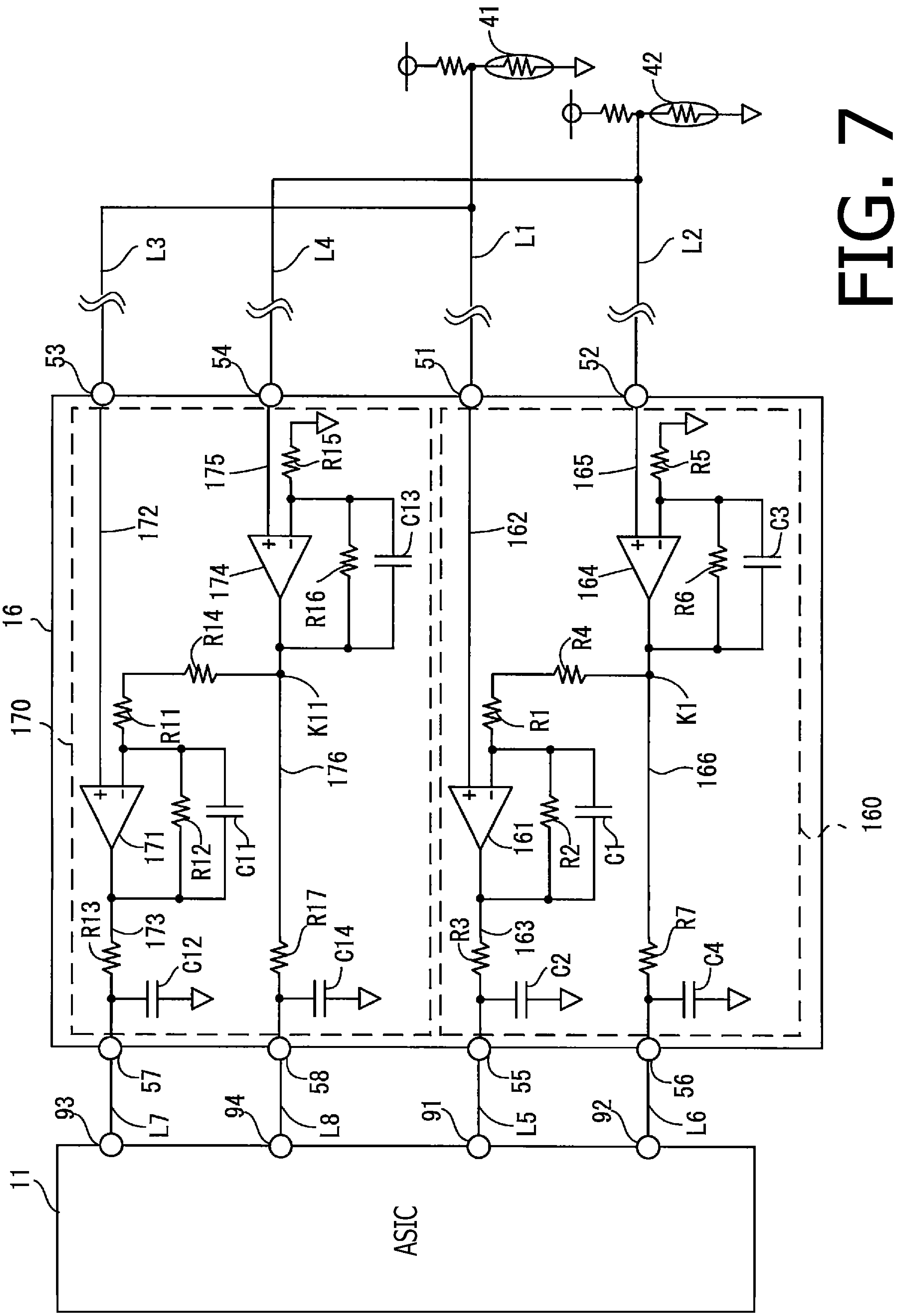

41
42
L3
L4
L1
L2
53
54
51
52
16
170
172
175
R15
C13
174
R16
R14
K11
R11
176
171
R12
C11
R13
173
C12
R17
C14
162
165
R5
C3
164
R6
R4
K1
R1
166
161
R2
C1
160
R3
163
C2
R7
C4
57
58
55
56
93
94
91
92
L7
L8
L5
L6
11
ASIC

FIG. 7

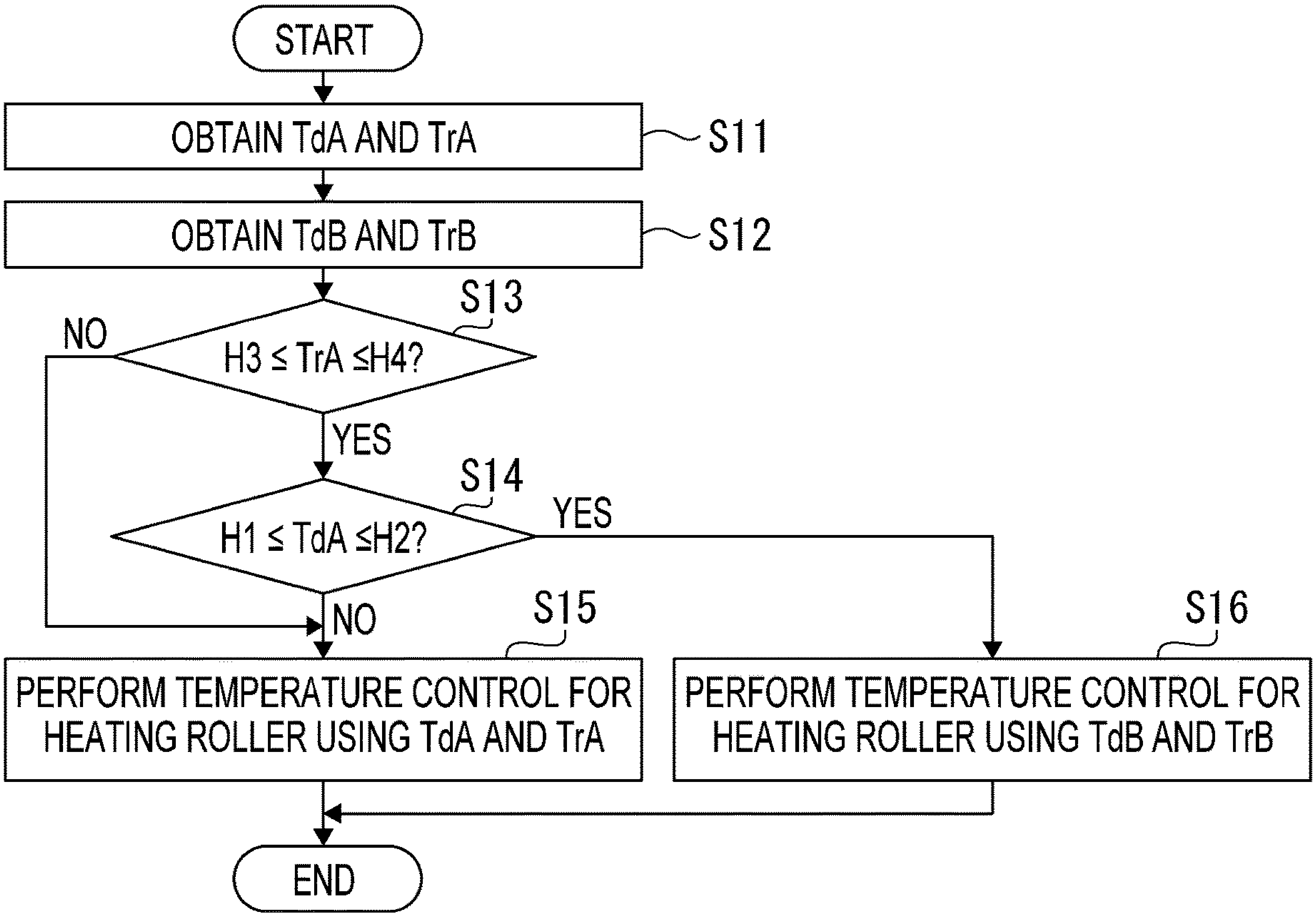

START
OBTAIN TdA AND TrA
S11
OBTAIN TdB AND TrB
S12
S13
NO
H3 ≤ TrA ≤H4?
YES
S14
H1 ≤ TdA ≤H2?
YES
NO
S15
S16
PERFORM TEMPERATURE CONTROL FOR HEATING ROLLER USING TdA AND TrA
PERFORM TEMPERATURE CONTROL FOR HEATING ROLLER USING TdB AND TrB
END

FIG. 8

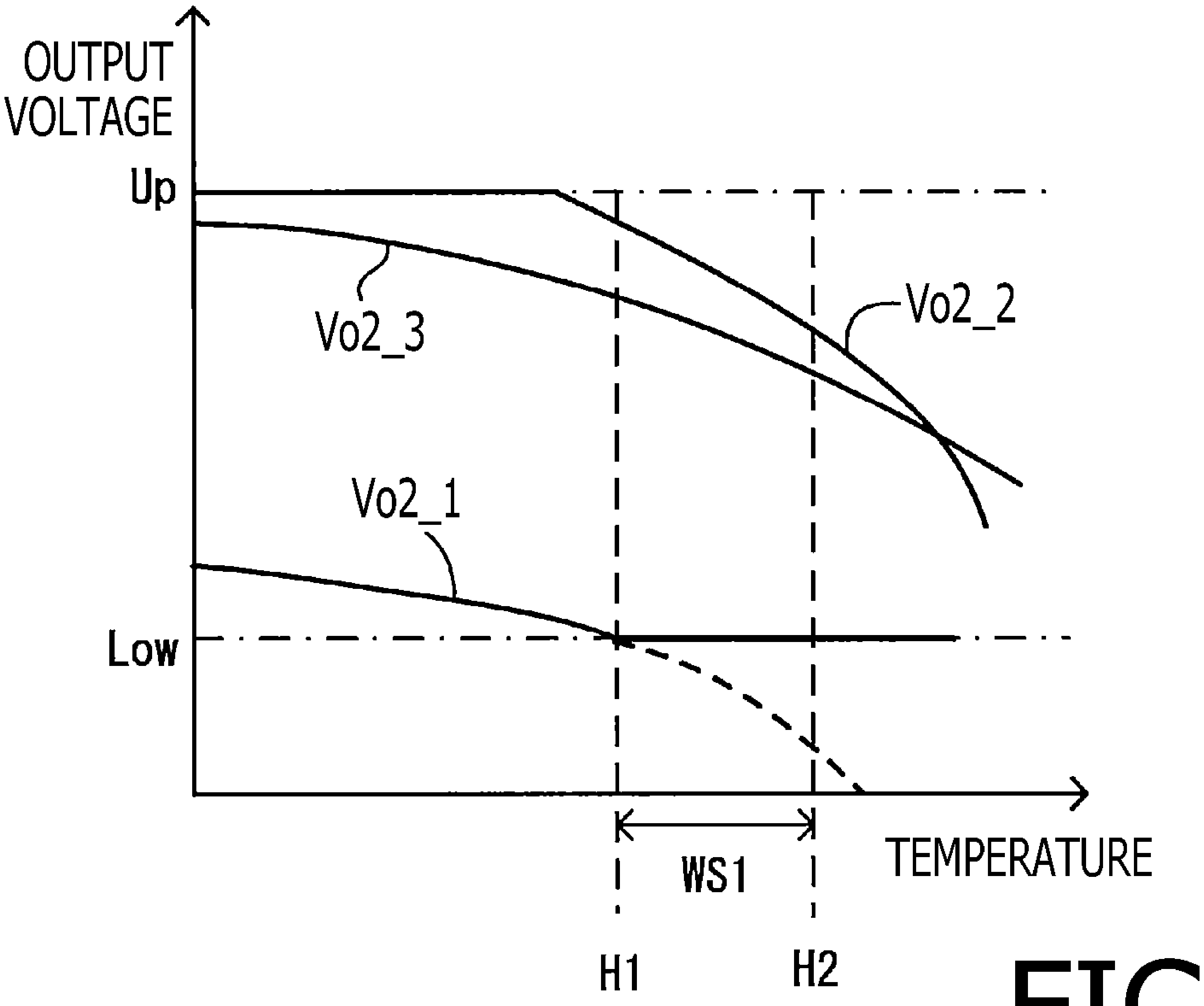


FIG. 9

IMAGE FORMING APPARATUS TO ACCURATELY DETERMINE TEMPERATURE OF HEATING MEMBER

CROSS-REFERENCE TO RELATED APPLICATION

This application claims priority under 35 U.S.C. § 119 from Japanese Patent Applications No. 2020-035428 filed on Mar. 3, 2020 and No. 2021-025204 filed on Feb. 19, 2021. The entire subject matter of the applications is incorporated herein by reference.

BACKGROUND

Technical Field

Aspects of the present disclosure are related to an image forming apparatus to determine a temperature of a heating member.

Related Art

An image forming apparatus has been known that is configured to determine a temperature of a heating member using a temperature sensor having a detection thermistor and a compensation thermistor. Specifically, a difference between detection values from the individual thermistors is amplified by an amplifier circuit, then analog-to-digital converted by a conversion circuit, and output to a microcomputer. The microcomputer determines the temperature of the heating member using the converted difference and the output value from the compensation thermistor.

SUMMARY

In general, it is known that a quantization error occurs when a conversion circuit converts an analog value into a digital value. Therefore, there is a concern that an error of the detected temperature relative to an actual temperature of the heating member might be increased due to the quantization error in the conversion circuit.

Aspects of the present disclosure are advantageous to provide one or more improved techniques for an image forming apparatus that make it possible to accurately determine a temperature of a heating member by reducing influences of a quantization error caused when a conversion circuit converts the temperature detected by a temperature sensor.

According to aspects of the present disclosure, an image forming apparatus is provided, which includes a heating member configured to heat a sheet on which a toner image is formed, a temperature sensor including a film configured to absorb infrared rays from the heating member, a detection thermistor configured to output a first detection value corresponding to a temperature of the film, and a compensation thermistor configured to output a second detection value corresponding to a temperature of a holder holding the film, a first amplifier configured to amplify a difference value between the first detection value and the second detection value with a first amplification factor, a second amplifier configured to amplify the difference value between the first detection value and the second detection value with a second amplification factor higher than the first amplification factor, a converter configured to generate first temperature information by performing analog-to-digital conversion of the difference value amplified with the first amplification factor, generate second temperature information by performing analog-to-digital conversion of the difference value amplified with the second amplification factor, and generate compensation temperature information by performing analog-to-digital conversion of the second detection value, and a temperature determiner configured to determine a temperature of the heating member based on the second temperature information and the compensation temperature information, in a particular temperature range, and determine the temperature of the heating member based on the first temperature information and the compensation temperature information, outside the particular temperature range.

According to aspects of the present disclosure, further provided is an image forming apparatus that includes a heating member configured to heat a sheet on which a toner image is formed, a temperature sensor including a detection thermistor configured to output a first detection value corresponding to a surface temperature of the heating member, and a compensation thermistor configured to output a second detection value corresponding to an environmental temperature of the temperature sensor, a first differential amplifier having a first gain and configured to receive an input value corresponding to the first detection value and an input value corresponding to the second detection value, and a second differential amplifier having a second gain and configured to receive an input value corresponding to the first detection value and an input value corresponding to the second detection value, the second gain being larger than the first gain, a converter configured to generate first temperature information by performing analog-to-digital conversion of an output value from the first differential amplifier, generate second temperature information by performing analog-to-digital conversion of an output value from the second differential amplifier, and generate compensation temperature information by performing analog-to-digital conversion of the second detection value, and a temperature determiner configured to determine a temperature of the heating member based on the second temperature information and the compensation temperature information, in a particular temperature range, and determine the temperature of the heating member based on the first temperature information and the compensation temperature information, outside the particular temperature range.

BRIEF DESCRIPTION OF THE ACCOMPANYING DRAWINGS

FIG. **1** is a longitudinal sectional view schematically showing a configuration of a laser printer in an illustrative embodiment according to one or more aspects of the present disclosure.

FIG. **2** is a block diagram showing an electrical configuration of the laser printer in the illustrative embodiment according to one or more aspects of the present disclosure.

FIG. **3** is an illustration for explaining a configuration of a temperature sensor in the illustrative embodiment according to one or more aspects of the present disclosure.

FIG. **4** is a graph, for explaining a particular temperature range, which shows changes in a temperature of a heating roller when a toner image formed on a sheet is thermally fixed by the fuser, in the illustrative embodiment according to one or more aspects of the present disclosure.

FIG. **5** shows temperature dependencies of output voltages each obtained by amplifying a difference voltage with a first amplification factor, in the illustrative embodiment according to one or more aspects of the present disclosure.

FIG. **6** shows temperature dependencies of output voltages each obtained by amplifying the difference voltage with a second amplification factor, in the illustrative embodiment according to one or more aspects of the present disclosure.

FIG. **7** is a schematic diagram showing a configuration of an amplifier circuit connected with an ASIC, in the illustrative embodiment according to one or more aspects of the present disclosure.

FIG. **8** is a flowchart showing a procedure of temperature control for the heating roller, in the illustrative embodiment according to one or more aspects of the present disclosure.

FIG. **9** is a graph, for explaining a conditional temperature range, which shows that individual output voltages, each obtained by amplifying the difference voltage with the second amplification factor, vary depending on the temperature of the heating roller, with respect to respective different temperatures indicated by compensation temperature information, in the illustrative embodiment according to one or more aspects of the present disclosure.

DETAILED DESCRIPTION

It is noted that various connections are set forth between elements in the following description. It is noted that these connections in general and, unless specified otherwise, may be direct or indirect and that this specification is not intended to be limiting in this respect. Aspects of the present disclosure may be implemented on circuits (such as application specific integrated circuits) or in computer software as programs storable on computer-readable media including but not limited to RAMs, ROMs, flash memories, EEPROMs, CD-media, DVD-media, temporary storage, hard disk drives, floppy drives, permanent storage, and the like.

Hereinafter, an image forming apparatus of an illustrative embodiment according to aspects of the present disclosure will be described with reference to the accompanying drawings. In the illustrative embodiment, the image forming apparatus is a laser printer to form an image on a sheet (e.g., recording paper or a transparency) using toner as a developer.

As shown in FIG. **1**, a laser printer **1** includes a sheet feeder **3**, an exposure device **4**, a process unit **6**, a fuser **8**, a controller **10**, and a housing **2** for accommodating the above elements **3**, **4**, **6**, **8**, and **10**.

The sheet feeder **3** includes a feed tray **31** for accommodating sheets S, a sheet pressing plate **32**, and a feeding mechanism **33**. The feeding mechanism **33** includes a pickup roller **33**A, a separation roller **33**B, a first conveyance roller **33**C, and a registration roller **33**D. In the sheet feeder **3**, sheets S in the feed tray **31** are brought to the pickup roller **33**A by the sheet pressing plate **32** and fed to the separation roller **33**B by the pickup roller **33**A. The sheets S are individually separated by the separation roller **33**B and are conveyed in a sheet-by-sheet basis by the first conveyance roller **33**C. The registration roller **33**D, after correcting the skew of a leading end of each individual sheet S, conveys each sheet S toward the process unit **6**.

The exposure device **4** includes a laser light source (not shown), a polygon mirror, a lens, and a reflector (which are shown with reference numerals omitted). In the exposure device **4**, laser light, emitted from the laser light source based on image data, is scanned on a surface of a below-mentioned photoconductive drum **61** of the process unit **6**. Thereby, an electrostatic latent image is formed on the surface of the photoconductive drum **61**.

The process unit **6** forms a toner image on a sheet S. The process unit **6** is disposed below the exposure device **4** in the housing **2**. The process unit **6** includes the photoconductive drum **61**, a charger **62**, a transfer roller **63**, a development roller **71**, a supply roller **72**, and a toner container **74** for storing dry toner.

In the process unit **6**, the surface of the photoconductive drum **61** is uniformly charged by the charger **62**, and thereafter, the electrostatic latent image based on the image data is formed on the surface of the photoconductive drum **61** by the laser light from the exposure device **4**. The toner in the toner container **74** is supplied to the development roller **71** via the supply roller **72**. The development roller **71** supplies the toner to the photoconductive drum **61** on which the electrostatic latent image is formed. Thereby, the electrostatic latent image is rendered visible, and the toner image is formed on the photoconductive drum **61**. Thereafter, when the sheet S fed by the sheet feeder **3** is conveyed between the photoconductive drum **61** and the transfer roller **63**, the toner image formed on the photoconductive drum **61** is transferred onto the sheet S.

The sheet S with the toner image transferred thereon is conveyed by the photoconductive drum **61** and the transfer roller **63** to the fuser **8**. The fuser **8** fixes the toner image onto the sheet S conveyed from the process unit **6**. The fuser **8** includes a heating roller **81** for heating the sheet S, and a pressure roller **82** for pinching the sheet S with the heating roller **81**. The heating roller **81** is a cylindrical roller rotatably held in the housing **2**. The pressure roller **82** is a roller rotatably held inside the housing **2**. In the fuser **8**, when the sheet S with the toner image transferred thereon is conveyed between the heating roller **81** and the pressure roller **82**, the toner image is thermally fixed onto the sheet S.

Heaters **83** are disposed inside the heating roller **81**. In the illustrative embodiment, the heaters **83** are two halogen lamps. Each heater **83** is formed in a shape extending with substantially the same length as a length of the heating roller **81** in a width direction of the heating roller **81**. The heaters **83** are arranged side by side inside the heating roller **81**.

The sheet S with the toner image thermally fixed thereon is discharged onto a discharge tray **22** by a second conveyance roller **23** and a discharge roller **24**.

As shown in FIG. **2**, the controller **10** is connected with the sheet feeder **3**, the exposure device **4**, the process unit **6**, and the fuser **8**, and controls operations of the aforementioned elements **3**, **4**, **6**, **8**, and **83**. Specifically, the controller **10** controls a motor for rotating each roller included in the sheet feeder **3**, a motor for rotating the heating roller **81** and the pressure roller **82** included in the fuser **8**, and further controls emission of light from the light source of the exposure device **4**.

The controller **10** is connected with a temperature sensor **40** configured to detect a temperature of the heating roller **81**. Detection voltages (i.e., below-mentioned first and second detection voltages Va and Vb) output from the temperature sensor **40** is repeatedly input into the controller **10** at a particular cycle.

The controller **10** controls the temperature of the heating roller **81** using the detection voltages output from the temperature sensor **40**. Specifically, the controller **10** controls the temperature of the heating roller **81** within a particular temperature range when fixing the toner onto the sheet in a printing process. On the other hand, the controller **10** controls the temperature of the heating roller **81** within a temperature range lower than the particular temperature range applied in the toner fixing, in a standby mode in which the laser printer **1** does not perform the printing process.

Next, the temperature sensor **40** will be described. The temperature sensor **40** is a non-contact type sensor. More specifically, in the illustrative embodiment, the temperature sensor **40** is a thermistor temperature sensor. As shown in FIG. **3**, the temperature sensor **40** includes a main body **44**, a film **43**, a detection thermistor **41**, and a compensation thermistor **42**. The main body **44** has an opening **44***b* that opens in a surface **44***a* facing the heating roller **81**. The opening **44***b* extends to a sensor housing space **44***c* for accommodating the detection thermistor **41** and the compensation thermistor **42** inside the main body **44**. An end, opposite to the surface **44***a*, of the opening **44***b* is closed by a film **43**. The opening **44***b* and the sensor housing space **44***c* are partitioned from each other with the film **43** provided at a boundary therebetween. The detection thermistor **41** is held to be fixed to the film **43**, in the sensor housing space **44***c*. The compensation thermistor **42** is held to be fixed to a wall that forms the sensor housing space **44***c*, in the sensor housing space **44***c*.

In the temperature sensor **40** configured as above, infrared rays radiated from the heating roller **81** are transmitted to the film **43** through the opening **44***b* and are absorbed by the film **43**. The detection thermistor **41** outputs a first detection voltage Va corresponding to a temperature of the film **43**. In other words, the detection thermistor **41** is configured to detect infrared radiation from the heating roller **81** and output the first detection voltage Va corresponding to a surface temperature of the heating roller **81**. The compensation thermistor **42** outputs a second detection voltage Vb corresponding to a temperature of the main body **44**. In other words, the compensation thermistor **42** is configured to output the second detection voltage Vb corresponding to an environmental temperature of the temperature sensor **40**. The first detection voltage Va is an analog signal of which a voltage value varies depending on the temperature of the film **43**. The second detection voltage Vb is an analog signal of which a voltage value varies depending on the temperature of the main body **44**. The second detection voltage Vb is used to compensate for the first detection voltage Va.

Subsequently, a configuration of the controller **10** will be described. The controller **10** includes an ASIC **11**, an energizing circuit **15**, and an amplifier circuit **16**.

The energizing circuit **15** has a triac as a switching element. The energizing circuit **15** is configured to switch a state of the heaters **83** between an energized state and a de-energized state. The energized state is a state in which the heaters **83** are supplied with an AC voltage from an AC power supply (not shown). The de-energized state is a state in which the heaters **83** are not supplied with the AC voltage.

The amplifier circuit **16** is configured to amplify a difference value between the first detection voltage Va and the second detection voltage Vb received from the temperature sensor **40**. The amplifier circuit **16** is further configured to amplify the second detection voltage Vb. A detailed configuration of the amplifier circuit **16** will be described later.

The ASIC **11** includes a CPU **12**, a memory **13**, and an ADC ("ADC" is an abbreviation of "Analog-to-Digital Converter") **14**. The ADC **14** is configured to perform analog-to-digital conversion of the difference value amplified by the amplifier circuit **16**, thereby generating temperature information Td. The ADC **14** is further configured to perform analog-to-digital conversion of the second detection voltage Vb amplified by the amplifier circuit **16**, thereby generating compensation temperature information Tr. The temperature information Td and the compensation temperature information Tr are digital signals that take discrete values.

The CPU **12** is configured to determine the temperature of the heating roller **81** using the temperature information Td and the compensation temperature information Tr generated by the ADC **14**. The memory **13** stores a temperature table that defines the correspondence between the temperature of the heating roller **81** and a combination of the temperature information Td and the compensation temperature information Tr. By referring to the temperature table, the CPU **12** determines, as the temperature of the heating roller **81**, a temperature associated with the combination of the temperature information Td and the compensation temperature information Tr. In another instance, the CPU **12** may calculate a temperature by an arithmetic operation using the temperature information Td and the compensation temperature information Tr, and may determine the calculated temperature as the temperature of the heating roller **81**.

Using the determined temperature of the heating roller **81**, the CPU **12** variably controls an energizing time to supply the AC voltage to the heaters **83** by the energizing circuit **15**. Specifically, the ASIC **11** generates a heater drive signal based on the temperature of the heating roller **81** and outputs the generated heater drive signal to the energizing circuit **15**. The heater drive signal is a signal to determine an amount of AC power supplied to the heaters **83** by the energizing circuit **15**. More specifically, the heater drive signal is a signal for on-off operating the triac.

Next, changes in the temperature of the heating roller **81** will be described. FIG. **4** shows changes in the temperature of the heating roller **81** when the fuser **8** is fixing a toner image onto a sheet S. More specifically, FIG. **4** shows changes in the temperature of the heating roller **81** during a period of time (t**1** to t**2**) when the sheet S passes between the heating roller **81** and the pressure roller **82**.

Before the time t**1**, the temperature of the heating roller **81** rises as the heaters **83** begin to be supplied with the AC power. At and after the time t**1**, the sheet S is pinched between the heating roller **81** and the pressure roller **82**, and the temperature of the heating roller **81** varies around 160[° C.]. Although the following features are not shown in FIG. **4**, at and after the time t**2**, the sheet S is not pinched between the heating roller **81** and the pressure roller **82**, and the temperature of the heating roller **81** temporarily increases. Therefore, while the toner image is being fixed onto the sheet S, the temperature of the heating roller **81** varies within the particular temperature range WS**1** from 150[° C.] to 200[° C.]. Namely, the particular temperature range WS**1** is considered as a temperature range within which the temperature of the heating roller **81** is likely to be while the toner image is being fixed onto the sheet S.

If a quantization error in the analog-to-digital conversion by the ADC **14** for the temperature of the heating roller **81** becomes large in the particular temperature range WS**1**, the toner image may not be properly fixed. The inventors focused on a fact that the temperature of the heating roller **81** changes within the particular temperature range WS**1** during the period of time when the toner image is being fixed on the sheet S. Then, the inventors came up with an idea of using the temperature information Td having a high resolution only in the particular temperature range WS**1** when the temperature of the heating roller **81** is included in the particular temperature range WS**1**. Specifically, when the temperature of the heating roller **81** is not included in the particular temperature range WS**1**, the temperature control for the heating roller **81** is performed using first temperature information TdA. The first temperature information TdA is temperature information Td having a certain range of resolution in the entire temperature range which the temperature of the heating roller **81** is considered likely to be within. On the other hand, when the temperature of the heating roller **81** is included in the particular temperature range WS**1**, the temperature control for the heating roller **81** is performed using second temperature information TdB. The second temperature information TdB has a higher resolution in the particular temperature range WS**1** than the first temperature information TdA.

Next, a principle for changing the resolution of the temperature information Td will be described. FIG. **5** shows temperature dependencies of output voltages Vo**1** each obtained by amplifying a difference voltage ΔV with a first amplification factor A**1**. The difference voltage ΔV is a voltage corresponding to a difference between the first detection voltage Va and the second detection voltage Vb. A horizontal axis indicates the temperature of the heating roller **81**. In FIG. **5**, "Vo**1**_*a*" and "Vo**1**_*b*" represent respective values of the output voltages Vo**1** corresponding to different second detection voltages Vb. FIG. **6** shows temperature dependencies of output voltages Vo**2** each obtained by amplifying the difference voltage ΔV with a second amplification factor A**2**. A horizontal axis indicates the temperature of the heating roller **81**. The second amplification factor A**2** is higher than the first amplification factor A**1**. Each amplification factor may not necessarily be a linear value but may be defined by a non-linear function. Further, a lower limit and an upper limit of a range of acceptable input voltages to the ADC **14** are shown as "Low" and "Up," respectively.

The output voltages Vo**1**_*a* and Vo**1**_*b* (see FIG. **5**) amplified with the first amplification factor A**1** decrease slowly as the temperature of the heating roller **81** increases. Namely, slopes, indicating the individual changes in the output voltages Vo**1**_*a* and Vo**1**_*b* with respect to the change in the temperature of the heating roller **81**, are small. On the other hand, the output voltages Vo**2**_*a* and Vo**2**_*b* (see FIG. **6**) amplified with the second amplification factor A**2** have larger slopes of their respective voltage values changing depending on the temperature of the heating roller **81** than the slopes of the output voltages Vo**1**_*a* and Vo**1**_*b* (see FIG. **5**) amplified with the first amplification factor A**1**. Therefore, in the particular temperature range WS**1**, the second temperature information TdB calculated using the output voltages Vo**2**_*a* and Vo**2**_*b* amplified with the second amplification factor A**2** has a higher resolution than the first temperature information TdA calculated using the output voltages Vo**1**_*a* and Vo**1**_*b* amplified with the first amplification factor A**1**.

On the other hand, with respect to the output voltage Vo**2** amplified with the second amplification factor A**2**, outside the particular temperature range WS**1**, there are temperatures at which voltage values of the said output voltage Vo**2** are higher than the upper limit "Up," and temperatures at which that voltage values of the said output voltage Vo**2** are lower than the lower limit "Low." The output voltage Vo**2** amplified with the second amplification factor A**2** is saturated to be the upper limit "Up" at such temperatures that voltage values of the said output voltage Vo**2** are higher than the upper limit "Up." Further, the output voltage Vo**2** amplified with the second amplification factor A**2** is saturated to be the lower limit "Low" at such temperatures that voltage values of the said output voltage Vo**2** are lower than the lower limit "Low." Therefore, outside the particular temperature range WS**1**, the first temperature information TdA is more accurate than the second temperature information TdB.

Next, a specific configuration of the amplifier circuit **16** will be described with reference to FIG. **7**. The amplifier circuit **16** has a first input terminal **51**, a second input terminal **52**, a third input terminal **53**, and a fourth input terminal **54** that are connected with the temperature sensor **40**. Specifically, the first input terminal **51** is connected with the detection thermistor **41** via a first connection line L**1**. Thereby, the first detection voltage Va is input into the first input terminal **51**. The second input terminal **52** is connected with the compensation thermistor **42** via a second connection line L**2**. Thereby, the second detection voltage Vb is input into the second input terminal **52**. The third input terminal **53** is connected with the detection thermistor **41** via a third connection line L**3** that branches off from the first connection line L**1**. Thereby, the first detection voltage Va is input into the third input terminal **53**. The fourth input terminal **54** is connected with the compensation thermistor **42** via a fourth connection line L**4** that branches off from the second connection line L**2**. Thereby, the second detection voltage Vb is input into the fourth input terminal **54**.

In addition, the amplifier circuit **16** has a first output terminal **55** and a third output terminal **57** that output the output voltages Vo. Further, the amplifier circuit **16** has a second output terminal **56** and a fourth output terminal **58** that output sub-output voltages Vs. Specifically, the first output terminal **55** is connected with a first difference voltage terminal **91** of the ASIC **11** via a connection line L**5**. The second output terminal **56** is connected with a first compensation voltage terminal **92** of the ASIC **11** via a connection line L**6**. The third output terminal **57** is connected with a second difference voltage terminal **93** of the ASIC **11** via a connection line L**7**. The fourth output terminal **58** is connected with a second compensation voltage terminal **94** of the ASIC **11** via a connection line L**8**.

The amplifier circuit **16** includes a first amplifier **160** and a second amplifier **170**. The first amplifier **160** is configured to amplify the difference voltage ΔV corresponding to the difference between the first detection voltage Va and the second detection voltage Vb, with the first amplification factor A**1**. The second amplifier **170** is configured to amplify the difference voltage ΔV corresponding to the difference between the first detection voltage Va and the second detection voltage Vb, with the second amplification factor A**2**. It is noted that the second amplification factor A**2** is larger than the first amplification factor A**1**. As described above, the difference voltage ΔV amplified by the first amplifier **160** with the first amplification factor A**1** may be referred to as the output voltage Vo**1**. Further, the difference voltage ΔV amplified by the second amplifier **170** with the second amplification factor A**2** may be referred to as the output voltage Vo**2**.

The first amplifier **160** includes a first main operational amplifier **161** and a first sub operational amplifier **164** that function as non-inverting amplifiers. A non-inverting input terminal of the first main operational amplifier **161** is connected with a first input line **162** leading to the first input terminal **51**. Thereby, the first detection voltage Va from the detection thermistor **41** is input into the non-inverting input terminal of the first main operational amplifier **161**. An output terminal of the first main operational amplifier **161** is connected with one end of the first output line **163** with which a resistor R**3** is connected in series. The other end of the first output line **163** is connected with a first output terminal **55**. An inverting input terminal and the output terminal, of the first main operational amplifier **161**, are connected with each other via a resistor R**2**. In the illustrative embodiment, a capacitor C**1** is connected in parallel with the resistor R**2**. The first output line **163** is connected with the signal ground via a capacitor C**2**.

A non-inverting input terminal of the first sub operational amplifier **164** is connected with a second input line **165** leading to the second input terminal **52**. Thereby, the second detection voltage Vb from the compensation thermistor **42** is input into the non-inverting input terminal of the first sub operational amplifier **164**. An inverting input terminal of the first sub operational amplifier **164** is connected with the signal ground via a resistor R**5**. An output terminal of the first sub operational amplifier **164** is connected with one end of a second output line **166** with which a resistor R**7** is connected in series. The other end of the second output line **166** is connected with the second output terminal **56**. The inverting input terminal and the output terminal, of the first sub operational amplifier **164**, are connected with each other via a resistor R**6**. In the illustrative embodiment, a capacitor C**3** is connected in parallel with the resistor R**6**. The second output line **166** is connected with the signal ground via a capacitor C**4**.

The inverting input terminal of the first main operational amplifier **161** and the output terminal of the first sub operational amplifier **164** are connected with each other via a resistor R**4**. Specifically, one end of the resistor R**4** is connected with a resistor R**1** leading to the inverting input terminal of the first main operational amplifier **161**. Further, the other end of the resistor R**4** is connected with a contact point K**1** on the second output line **166**. The contact point K**1** is between the register R**7** and a contact point with which the register R**6** is connected on the second output line **166**.

In the first amplifier **160** configured as above, the second detection voltage Vb input via the second input terminal **52** is amplified by the first sub operational amplifier **164** and then output to the second output terminal **56**. From the output terminal of the first sub operational amplifier **164**, a voltage, obtained by amplifying with a third gain G**3** (=(R**5**+R**6**)/R**5**) the second detection voltage Vb input into the non-inverting input terminal of the first sub operational amplifier **164**, is output as a sub-output voltage Vs**1**. The sub-output voltage Vs**1**, output from the first sub operational amplifier **164**, is also output to the inverting input terminal of the first main operational amplifier **161** via the resistor R**4**.

The first main operational amplifier **161** amplifies the difference between the sub-output voltage Vs**1** input into the inverting input terminal of the first main operational amplifier **161** and the first detection voltage Va input into the non-inverting input terminal of the first main operational amplifier **161**. Then, the first main operational amplifier **161** outputs the output voltage Vo**1** to the first output terminal **55**. Here, a resistance value of resistor R**2** is larger than a resistance value of resistor R**1**. Thus, from the output terminal of the first main operational amplifier **161**, a voltage, obtained by amplifying with a first gain G**1** (=(R**1**+R**2**)/R**1**) the difference between the first detection voltage Va input into the non-inverting input terminal of the first main operational amplifier **161** and the sub-output voltage Vs**1** output from the first sub operational amplifier **164**, is output as the output voltage Vo**1**. It is noted that the first gain G**1** is a major factor for determining the first amplification factor A**1**.

In the illustrative embodiment, the third gain G**3** has only to be set to such a value that the second detection voltage Vb amplified with the third gain G**3** is not saturated in a range of temperatures to be detected using the second detection voltage Vb amplified. For instance, the range of temperatures to be detected using the second detection voltage Vb amplified is a temperature range between a temperature (e.g., 0[° C.]) set as a lower limit in operating conditions for the laser printer **1** and a temperature (e.g., 150[° C.]) set as an upper limit of a heat-resistant temperature range for the temperature sensor **40**.

The second amplifier **170** includes a second main operational amplifier **171** and a second sub operational amplifier **174** that function as non-inverting amplifiers. A non-inverting input terminal of the second main operational amplifier **171** is connected with a third input line **172** leading to the third input terminal **53**. Thereby, the first detection voltage Va from the detection thermistor **41** is input into the non-inverting input terminal of the second main operational amplifier **171**. An output terminal of the second main operational amplifier **171** is connected with one end of the third output line **173** with which a resistor R**13** is connected in series. The other end of the third output line **173** is connected with the third output terminal **57**. An inverting input terminal and an output terminal, of the second main operational amplifier **171**, are connected with each other via a resistor R**12**. In the illustrative embodiment, a capacitor C**11** is connected in parallel with the resistor R**12**. The third output line **173** is connected with the signal ground via a capacitor C**12**.

A non-inverting input terminal of the second sub operational amplifier **174** is connected with a fourth input line **175** leading to the fourth input terminal **54**. Thereby, the second detection voltage Vb from the compensation thermistor **42** is input into the non-inverting input terminal of the second sub operational amplifier **174**. An inverting input terminal of the second sub operational amplifier **174** is connected with the signal ground via a resistor R**15**. An output terminal of the second sub operational amplifier **174** is connected with one end of the fourth output line **176** with which a resistor R**17** is connected in series. The other end of the fourth output line **176** is connected with the fourth output terminal **58**. The inverting input terminal and the output terminal, of the second sub operational amplifier **174**, are connected with each other via a resistor R**16**. In the illustrative embodiment, a capacitor C**13** is connected in parallel with the resistor R**16**. The fourth output line **176** is connected with the signal ground via a capacitor C**14**.

The inverting input terminal of the second main operational amplifier **171** and the output terminal of the second sub operational amplifier **174** are connected with each other via a resistor R**14**. Specifically, one end of the resistor R**14** is connected with a resistor R**11** leading to the inverting input terminal of the second main operational amplifier **171**. The other end of the resistor R**14** is connected with a contact K**11** on the fourth output line **176**. The contact K**11** is between the resistor R**17** and a contact with which the resistor R**16** is connected on the fourth output line **176**.

In the second amplifier **170** configured as above, the second detection voltage Vb input via the fourth input terminal **54** is amplified by the second sub operational amplifier **174** and then output from the fourth output terminal **58**. From the output terminal of the second sub operational amplifier **174**, a voltage, obtained by amplifying with a fourth gain G**4** (=(R**15**+R**16**)/R**15**) the voltage input into the non-inverting input terminal of the second sub operational amplifier **174**, is output as a sub-output voltage Vs**2**. The sub-output voltage Vs**2**, output from the second sub operational amplifier **174**, is also output to the inverting input terminal of the second main operational amplifier **171** via the resistor R**14**.

The second main operational amplifier **171** amplifies the difference between the sub-output voltage Vs**2** input into the inverting input terminal of the second main operational amplifier **171** and the first detection voltage Va input into the non-inverting input terminal of the second main operational amplifier **171**. Then, the second main operational amplifier **171** outputs the output voltage Vo**2** to the third output terminal **57**. Here, a resistance value of the resistor R**12** is larger than a resistance value of resistor R**11**. Thereby, from the output terminal of the second main operational amplifier **171**, a voltage, obtained by amplifying with a second gain G**2** (=(R**11**+R**12**)/R**11**) the difference between the first detection voltage Va input into the non-inverting input terminal of the second main operational amplifier **171** and sub-output voltage Vs**2** input into the inverting input terminal of the second main operational amplifier **171**, is output as the output voltage Vo**2**. The resistance values of the individual resistors R**1**, R**2**, R**11**, and R**12** are set to such values that the second gain G**2** is larger than the first gain G**1**. In the illustrative embodiment, the fourth gain G**4** has only to be set to such a value that the sub-output voltage Vs**2** is not saturated in a range of temperatures to be detected using the second detection voltage Vb amplified.

The output voltage Vo**1** input via the first difference voltage terminal **91** and the sub-output voltage Vs**1** input via the first compensation voltage terminal **92** are input into the ADC **14** of the controller **10**. The ADC **14** performs analog-to-digital conversion of the output voltage Vo**1** and calculates the first temperature information TdA. Further, the ADC **14** performs analog-to-digital conversion of the sub-output voltage Vs**1** amplified and calculates first compensation temperature information TrA. The output voltage Vo**2** input via the second difference voltage terminal **93** and the sub-output voltage Vs**2** input via the second compensation voltage terminal **94** are input to the ADC **14** of the controller **10**. The ADC **14** performs analog-to-digital conversion of the output voltage Vo**2** and calculates the second temperature information TdB. Further, the ADC **14** performs analog-to-digital conversion of the sub-output voltage Vs**2** and calculates second compensation temperature information TrB.

Subsequently, temperature control using the first temperature information TdA, the second temperature information TdB, the first compensation temperature information TrA, and the second compensation temperature information TrB will be described with reference to FIG. **8**. The process shown in FIG. **8** is a process to be executed by the CPU **12** in response to the laser printer **1** beginning to fix the toner image onto the sheet S.

In S**11**, the CPU **12** obtains the first temperature information TdA and the first compensation temperature information TrA generated by the ADC **14**. In S**12**, the CPU **12** obtains the second temperature information TdB and the second compensation temperature information TrB generated by the ADC **14**.

In S**13**, the CPU **12** determines whether a temperature indicated by the first compensation temperature information TrA is included in a conditional temperature range WS**2**. The conditional temperature range WS**2** is a range of the temperature indicated by the compensation temperature information Tr to accurately detect the second temperature information TdB in the particular temperature range WS**1**. FIG. **9** shows temperature dependencies of output voltages Vo**2** each obtained by amplifying the difference voltage ΔV with the second amplification factor A**2**. In FIG. **9**, an output voltage Vo**2_1** is an output voltage when the compensation temperature information Tr indicates "10° C." An output voltage Vo**2_2** is an output voltage when the compensation temperature information Tr indicates "80° C." An output voltage Vo**2_3** is an output voltage when the compensation temperature information Tr indicates "100° C."

The output voltage Vo**2_1** is saturated to be the lower limit "Low" of the range of acceptable input voltages to the ADC **14**, in the particular temperature range WS**1**. It is noted that, hereinafter, the range of acceptable input voltages to the ADC **14** may be simply referred to as the "input voltage range." This is because the output voltage Vo**2_1**, amplified with the second amplification factor A**2**, is lower than the lower limit "Low" in the particular temperature range WS**1**, as indicated by a dashed line in FIG. **9**. Namely, the second temperature information TdB calculated using the first detection voltage Va**_1** is inaccurate in the particular temperature range WS**1**. On the other hand, the output voltage Vo**2_2** and the output voltage Vo**2_3** have their values between the upper limit "Up" and the lower limit "Low" of the input voltage range, in the particular temperature range WS**1**.

Therefore, in the illustrative embodiment, the range of the temperature indicated by the first compensation temperature information TrA in the particular temperature range WS**1** is set to the conditional temperature range WS**2** in which the second temperature information TdB is not rendered inaccurate. For instance, the conditional temperature range is a temperature range within which the temperature of the main body **44** of the temperature sensor **40** is assumed to be while the toner image is being fixed onto the sheet S. Specifically, for instance, the conditional temperature range is a temperature range having a lower limit H**3** of 20[° C.] and an upper limit H**4** of 125[° C.].

When determining in S**13** that the temperature indicated by the first compensation temperature information TrA is included in the conditional temperature range WS**2** (S**13**: Yes), the CPU **12** goes to S**14**. In S**14**, the CPU **12** determines whether a temperature indicated by the first temperature information TdA is included in the particular temperature range WS**1**. Specifically, in S**13**, the CPU **12** determines whether the temperature indicated by the first compensation temperature information TrA is equal to or higher than the lower limit H**3** of the conditional temperature range WS**2** and is equal to or lower than the upper limit H**4** of the conditional temperature range WS**2**.

When making an affirmative determination in S**13**, i.e., determining that the temperature indicated by the first compensation temperature information TrA is included in the conditional temperature range WS**2** (S**13**: Yes), the CPU **12** goes to S**14**. In S**14**, the CPU **12** determines whether the temperature of the heating roller **81** is included in the particular temperature range WS**1**. Specifically, in the illustrative embodiment, the CPU **12** determines in S**14** whether the temperature indicated by the first temperature information TdA is equal to or higher than the lower limit H**1** of the particular temperature range WS**1** and is equal to or lower than the upper limit H**2** of the particular temperature range WS**1**.

When making an affirmative determination in S**14**, i.e., determining that the temperature of the heating roller **81** is included in the particular temperature range WS**1** (S**14**: Yes), the CPU **12** goes to S**16**. When the temperature of the heating roller **81** is included in the particular temperature range WS**1**, a resolution of the temperature indicated by the second temperature information TdB is higher than a resolution of the temperature indicated by the first temperature information TdA. Therefore, in S**16**, the CPU **12** performs temperature control for the heating roller **81** using the second temperature information TdB and the second compensation temperature information TrB. As described above, by referring to the temperature table, the CPU **12** determines the temperature of the heating roller **81** corresponding to the combination of the second temperature information TdB and the second compensation temperature information TrB. Then, the CPU **12** generates a heater drive signal using the determined temperature, and outputs the generated heater drive signal to the energizing circuit **15**.

When determining that the temperature indicated by the first compensation temperature information TrA is not included in the conditional temperature range WS**2** (S**13**: No), or determining that the temperature of the heating roller **81** is not included in the particular temperature range WS**1** (S**14**: No), the CPU **12** goes to S**15**. When the CPU **12** proceeds to S**15**, the second temperature information TdB is more inaccurate than the first temperature information TdA. Therefore, in the illustrative embodiment, the temperature control for the heating roller **81** is performed using the first temperature information TdA and the first compensation temperature information TrA.

After completion of **S15** or **S16**, the CPU **12** once terminates the process shown in FIG. **8**.

The illustrative embodiment described above produces the following effects. The laser printer **1** includes the first amplifier **160** and the second amplifier **170**. The first amplifier **160** amplifies with the first amplification factor A**1** the difference between the first detection voltage Va and the second detection voltage Vb output from the temperature sensor **40**. The second amplifier **170** amplifies with the second amplification factor A**2** the difference between the first detection voltage Va and the second detection voltage Vb. The ADC **14** performs analog-to-digital conversion of the difference amplified by the first amplifier **160** and generates the first temperature information TdA. Further, the ADC **14** performs analog-to-digital conversion of the difference amplified by the second amplifier **170** and generates the second temperature information TdB. The CPU **12** determines the temperature of the heating roller **81** in the particular temperature range WS**1** based on the second temperature information TdB and the second compensation temperature information TrB. Further, the CPU **12** determines the temperature of the heating roller **81** outside the particular temperature range WS**1** based on the first temperature information TdA and the first compensation temperature information TrA.

Thereby, in the particular temperature range WS**1**, the temperature of the heating roller **81** is determined using the second temperature information TdB that has a high temperature resolution in the particular temperature range WS**1**. Hence, it is possible to accurately detect the temperature of the heating roller **81** by reducing influences of a quantization error caused when the ADC **14** converts the detected temperature of the heating roller **81**.

The first amplifier **160** has the first main operational amplifier **161** and the resistors R**1** and R**2** for setting the first amplification factor A**1** of the first main operational amplifier **161**. The second amplifier **170** has the second main operational amplifier **171** and the resistors R**11** and R**12** for setting the second amplification factor A**2** of the second main operational amplifier **171**. Thus, by adjusting the resistance differences among the individual resistors R**1**, R**2**, R**11**, and R**12**, it is possible to determine how large or small the respective amplification factors A**1** and A**2** of the first amplifier **160** and the second amplifier **170** are relative to each other.

When the temperature indicated by the first temperature information TdA is included in the particular temperature range WS**1**, the CPU **12** performs temperature control for the heating roller **81** using the temperature determined based on the second temperature information TdB and the second compensation temperature information TrB. Thereby, it is possible to accurately control the temperature of the heating roller **81**.

When the temperature indicated by the first compensation temperature information TrA is included in the conditional temperature range WS**2**, and the temperature indicated by the first temperature information TdA is included in the particular temperature range WS**1**, the CPU **12** performs temperature control for the heating roller **81** using the temperature determined based on the second temperature information TdB and the second compensation temperature information TrB. Thereby, it is possible to further accurately control the temperature of the heating roller **81**.

When the temperature indicated by the first compensation temperature information TrA is not included in the conditional temperature range WS**2**, or the temperature indicated by the first temperature information Td is not included in the particular temperature range WS**1**, the CPU **12** performs temperature control for the heating roller **81** using the temperature determined based on the first temperature information TdA and the first compensation temperature information TrA. Thereby, a reduction in accuracy for the temperature control may be suppressed as much as possible.

Hereinabove, the illustrative embodiment according to aspects of the present disclosure has been described. Aspects of the present disclosure may be practiced by employing conventional materials, methodology and equipment. Accordingly, the details of such materials, equipment and methodology are not set forth herein in detail. In the previous descriptions, numerous specific details are set forth, such as specific materials, structures, chemicals, processes, etc., in order to provide a thorough understanding of the present disclosure. However, it should be recognized that aspects of the present disclosure may be practiced without reapportioning to the details specifically set forth. In other instances, well known processing structures have not been described in detail, in order not to unnecessarily obscure the present disclosure.

Only an exemplary illustrative embodiment of the present disclosure and but a few examples of their versatility are shown and described in the present disclosure. It is to be understood that aspects of the present disclosure are capable of use in various other combinations and environments and are capable of changes or modifications within the scope of the inventive concept as expressed herein. For instance, the following modifications may be feasible.

(Modifications)

In S**14** of the process shown in FIG. **8**, the CPU **12** may determine whether the temperature of the heating roller **81** is included in the particular temperature range WS**1**, using the second temperature information TdB.

In S**13** of the process shown in FIG. **8**, the CPU **12** may determine whether a temperature indicated by the second compensation temperature information TrB is included in the conditional temperature range WS**2**.

It is merely one example that the temperature range, within which the temperature of the heating roller **81** is likely to be while the toner image is being fixed onto the sheet S, is used as the particular temperature range WS**1**. For instance, a temperature range, within which the temperature of the heating roller **81** is likely to be when the laser printer **1** is in the standby mode in which the laser printer **1** does not perform a printing process, may be used as the particular temperature range WS**1**.

The conditional temperature range WS**2** and the particular temperature range WS**1** may overlap in some temperatures. For instance, the upper limit H**4** of the conditional temperature range WS**2** may be higher than the lower limit H**1** of the particular temperature range WS**1**.

Functions of a "temperature determiner" and a "temperature controller" according to aspects of the present disclosure may not necessarily be performed by the ASIC **11**. For instance, the laser printer **1** may include a plurality of ASICs and/or a plurality of CPUs. In such a case, the functions of determining and controlling the temperature of the heating roller **81** may be performed by at least one of the ASICs and/or the CPUs.

The image forming apparatus according to aspects of the present disclosure is not limited to the laser printer **1** but may be a copy machine or a multi-function peripheral. The image forming apparatus may also be a color printer having a plurality of process units corresponding to respective different colors.

A heating member according to aspects of the present disclosure is not limited to the heating roller **81**. For instance, the heating member may be a heating belt that includes an endless belt and a heater configured to heat an inner circumferential surface of the belt. In another instance, the heating member may be an externally-heated type heating member, which includes a rotatable body including a roller or a belt, and a heater configured to heat an outer circumferential surface of the rotatable body.

The following shows examples of associations between elements exemplified in the aforementioned illustrative embodiment and modifications and elements according to aspects of the present disclosure. The laser printer **1** may be an example of an "image forming apparatus" according to aspects of the present disclosure. The heating roller **81** may be an example of a "heating member" according to aspects of the present disclosure. The temperature sensor **40** may be an example of a "temperature sensor" according to aspects of the present disclosure. The film **43** may be an example of a "film" according to aspects of the present disclosure. The detection thermistor **41** may be an example of a "detection thermistor" according to aspects of the present disclosure. The compensation thermistor **42** may be an example of a "compensation thermistor" according to aspects of the present disclosure. The main body **44** of the temperature sensor **40** may be an example of a "holder" according to aspects of the present disclosure. The first amplifier **160** may be an example of a "first amplifier" according to aspects of the present disclosure. The second amplifier **170** may be an example of a "second amplifier" according to aspects of the present disclosure. The ADC **14** may be an example of a "converter" according to aspects of the present disclosure. The CPU **12** may be an example of a "temperature determiner" according to aspects of the present disclosure. The CPU **12** may be an example of a "temperature controller" according to aspects of the present disclosure. The first detection voltage Va may be an example of a "first detection value" according to aspects of the present disclosure. The second detection voltage Vb may be an example of a "second detection value" according to aspects of the present disclosure. The resistors R**1** and R**2** may be included in examples of a "first resistor" according to aspects of the present disclosure. The resistors R**11** and R**12** may be included in examples of a "second resistor" according to aspects of the present disclosure. The first main operational amplifier **161** may be an example of a "first output amplifier" according to aspects of the present disclosure, and may be an example of a "first differential amplifier" according to aspects of the present disclosure. The second main operational amplifier **171** may be an example of a "second output amplifier" according to aspects of the present disclosure, and may be an example of a "second differential amplifier" according to aspects of the present disclosure.

What is claimed is:

1. An image forming apparatus comprising:

a heating member configured to heat a sheet on which a toner image is formed;

a temperature sensor comprising:

a film configured to absorb infrared rays from the heating member;

a detection thermistor configured to output a first detection value corresponding to a temperature of the film; and

a compensation thermistor configured to output a second detection value corresponding to a temperature of a holder holding the film;

a first amplifier configured to amplify a difference value between the first detection value and the second detection value with a first amplification factor;

a second amplifier configured to amplify the difference value between the first detection value and the second detection value with a second amplification factor higher than the first amplification factor;

a converter configured to:

generate first temperature information by performing analog-to-digital conversion of the difference value amplified with the first amplification factor;

generate second temperature information by performing analog-to-digital conversion of the difference value amplified with the second amplification factor; and

generate compensation temperature information by performing analog-to-digital conversion of the second detection value; and

a temperature determiner configured to:

determine a temperature of the heating member based on the second temperature information and the compensation temperature information, in a particular temperature range; and

determine the temperature of the heating member based on the first temperature information and the compensation temperature information, outside the particular temperature range.

2. The image forming apparatus according to claim **1**,

wherein the first amplifier comprises:

a first operational amplifier configured to amplify a value corresponding to the difference value; and

a first resistor that sets an amplification factor of the first operational amplifier to the first amplification factor, and

wherein the second amplifier comprises:

a second operational amplifier configured to amplify a value corresponding to the difference value; and

a second resistor that sets an amplification factor of the second operational amplifier to the second amplification factor.

3. The image forming apparatus according to claim **1**,

wherein the first amplifier comprises a first output amplifier having a first gain and configured to output a first output voltage to the converter, and

wherein the second amplifier comprises a second output amplifier having a second gain and configured to output a second output voltage to the converter, the second gain being larger than the first gain.

4. The image forming apparatus according to claim **1**, further comprising a temperature controller configured to control the temperature of the heating member using a temperature determined based on the second temperature information and the compensation temperature information, when a temperature indicated by the first temperature information or the second temperature information is included in the particular temperature range.

5. The image forming apparatus according to claim **4**, wherein the temperature controller is further configured to control the temperature of the heating member using the temperature determined based on the second temperature information and the compensation temperature information, when a temperature indicated by the compensation temperature information is included in a conditional temperature range, and the temperature indicated by the first temperature information or the second temperature information is included in the particular temperature range.

6. The image forming apparatus according to claim **5**, wherein the conditional temperature range is a temperature range within which the temperature of the holder of the temperature sensor is assumed to be when the sheet with the toner image formed is heated by the heating member.

7. The image forming apparatus according to claim **4**, wherein the temperature controller is further configured to control the temperature of the heating member using a temperature determined based on the first temperature information and the compensation temperature information, when the temperature indicated by the compensation temperature information is not included in the conditional temperature range, or the temperature indicated by the first temperature information or the second temperature information is not included in the particular temperature range.

8. The image forming apparatus according to claim **1**, wherein the particular temperature range is a temperature range within which the temperature of the heating member is likely to be when the sheet with the toner image formed is heated by the heating member.

9. An image forming apparatus comprising:

a heating member configured to heat a sheet on which a toner image is formed;

a temperature sensor comprising:

a detection thermistor configured to output a first detection value corresponding to a surface temperature of the heating member; and

a compensation thermistor configured to output a second detection value corresponding to an environmental temperature of the temperature sensor;

a first differential amplifier having a first gain and configured to receive an input value corresponding to the first detection value and an input value corresponding to the second detection value; and

a second differential amplifier having a second gain and configured to receive an input value corresponding to the first detection value and an input value corresponding to the second detection value, the second gain being larger than the first gain;

a converter configured to:

generate first temperature information by performing analog-to-digital conversion of an output value from the first differential amplifier;

generate second temperature information by performing analog-to-digital conversion of an output value from the second differential amplifier; and

generate compensation temperature information by performing analog-to-digital conversion of the second detection value; and

a temperature determiner configured to:

determine a temperature of the heating member based on the second temperature information and the compensation temperature information, in a particular temperature range; and

determine the temperature of the heating member based on the first temperature information and the compensation temperature information, outside the particular temperature range.

10. The image forming apparatus according to claim **9**, further comprising a temperature controller configured to control the temperature of the heating member using a temperature determined based on the second temperature information and the compensation temperature information, when a temperature indicated by the first temperature information or the second temperature information is included in the particular temperature range.

11. The image forming apparatus according to claim **10**, wherein the temperature controller is further configured to control the temperature of the heating member using the temperature determined based on the second temperature information and the compensation temperature information, when a temperature indicated by the compensation temperature information is included in a conditional temperature range, and the temperature indicated by the first temperature information or the second temperature information is included in the particular temperature range.

12. The image forming apparatus according to claim **11**, wherein the conditional temperature range is a temperature range within which a temperature of a holder of the temperature sensor is assumed to be when the sheet with the toner image formed is heated by the heating member.

13. The image forming apparatus according to claim **10**, wherein the temperature controller is further configured to control the temperature of the heating member using a temperature determined based on the first temperature information and the compensation temperature information, when the temperature indicated by the compensation temperature information is not included in the conditional temperature range, or the temperature indicated by the first temperature information or the second temperature information is not included in the particular temperature range.

14. The image forming apparatus according to claim **9**, wherein the particular temperature range is a temperature range within which the temperature of the heating member is likely to be when the sheet with the toner image formed is heated by the heating member.

* * * * *